

Stated Meeting, April 21, 1865.

Present eleven members.

Dr. WOOD, President, in the chair.

Photographs of Rear Admiral Davis, Rear Admiral Dupont, Colonel S. H. Long, Captain T. J. Lee, Mr. Edward Everett, Dr. Franklin Bache, Major-General Humphreys, Brigadier-General Abbott, Brevet Major-General Totten, and Dr. Franklin (copied from the portrait in the Society's rooms), were presented by Colonel Hartman Bache. A photograph of Dr. Dohrn was received from Stettin, and one of Dr. Coates was presented by himself.

A letter was received from Mr. Charles Hale, Consul-General of the United States, in Egypt, dated Alexandria, November 1, 1864, enclosing a circular letter of M. Miani, dated Alexandria, 26th September, in reference to his proposed expedition into the interior of Africa, in the summer of the present year.

MONSIEUR LE CONSUL GÉNÉRAL :

Les voyages du soussigné dans l'Afrique centrale, pour la découverte des origines du Nil, sont déjà connus.

Après la publication de son parallèle géographique contre Speke et Grant, tous les savants, qui ont mis en doute la découverte des Anglais, sont très favorables au soussigné, et par cette circonstance il cherche d'organiser une nouvelle expédition par souscriptions.

Venise, malgré réduite dans un état déplorable, malheureuse mais toujours généreuse, a lui fait cadeau des verroteries, armes et munitions.

Des rivalités a lui fait refuser l'appui du gouvernement Egyptien, par conséquence, si Monsieur le Consul-Général aura la bonté d'envoyer aux sociétés savantes de sa grande nation, les cartes ci-jointes, peut-être qu'on daignera agrandir ses moyens, et on devrait même lui donner un homme de quelque spécialité scientifique qui l'accompagne.

Monsieur le Consul-Général, implore la protection de votre patrie un homme qui est né Republicain, qui s'est battu à Venise pour la République, et quinze années se sont déjà écoulées qu'il est protégé par votre noble nation.

Le soussigné sait qu'en Amérique la science n'a pas de patrie, et en attendant l'honneur qu'il demande, agrééz, Monsieur le Consul-Général, les sentiments distingués de gratitude de votre

Très humble et très dévoué serviteur, MIANI.

ALEXANDRIE, 26 Septembre, 1864.

P. S. L'expédition aura lieu l'été de l'année prochaine.

Letters of invoice were received from the Natural History Society at Riga, September 13, the Royal Prussian Academy, November 11, and M. Des Moulins, dated Bordeaux, January 29, 1865.

Donations for the Library were received from the Prussian Academy and Horticultural Society at Berlin, the Natural Historical Society of Holland, the French Congress of Science, and M. Des Moulins of Bordeaux.

Pending nominations, Nos. 534 to 539, were read, spoken to, and balloted for.

Dr. Coates addressed the Society, inquiring what were the most appropriate means of showing its sympathy with the nation in its grief at the wicked assassination of the President of the United States, on the evening of Friday, 14th instant.

The President remarked that the mourning drapery which covered the chair of Dr. Franklin, used by the presiding officer at the meetings of the Society, had been ordered by the Society to be made for it at the time of President Jefferson's death, as he had recently observed in searching the old minutes.

Mr. Fraley moved that a committee of three be appointed to draw up suitable resolutions to express the sorrow of the Society.

The committee were appointed as follows: Mr. Fraley, Dr. Coates, and Mr. Price, who drafted the following preamble and resolutions, which were adopted:

The American Philosophical Society, uniting with the whole of the loyal people of the Union, deplore the sudden and violent death of Abraham Lincoln, the President of the United States, and deem it proper to perpetuate on their records their sorrow for this great national bereavement, and their estimation of the worth and virtues of the departed Magistrate and Man; therefore,

Resolved, That it is with unfeigned mourning we receive the dispensation of Providence, that has so suddenly and mysteriously permitted the removal of the Head of the Nation at a moment when he had apparently united all hearts in reliance upon his ability, wisdom, and mercy, and when all lovers of their country were rejoicing in the certainty of an honorable peace, and the restoration of the bonds of union and fraternal concord by his instrumentality.

Resolved, That the rebellion, which has caused the sacrifice of so many valuable lives and of so much property, and which has engendered so much sectional bitterness, crowned at last in its iniquity by the murder of the President, had its origin in a political and social system alien to the true principles of our National Government, subversive of human rights and human freedom; and its success would have been a great calamity, not only to the United States, but to the world.

Resolved, That bowing in humble submission to the dispensation that has not permitted Abraham Lincoln to close the war on the basis of mercy, charity, and amnesty, that he had publicly announced should be his guides to national peace and union, we trust that in the hands to which God has now committed the powers of the Government, justice shall be made potent to avenge the wrongs of the nation, and to give to mercy its appropriate power and place.

Resolved, That this Society will, by all its influence and power, support the Government in bringing the rebellion to an end, and in re-establishing the rule of the Constitution and the laws.

Resolved, That as a testimony of respect for the memory of the deceased Chief Magistrate of the Republic, the chair of the presiding officer of the Society be draped with mourning for six months.

Mr. Chase made a communication on the relation of magnetism and the magnetic declination to gravity.

In my first communication on the diurnal variation of the barometer [Proceedings A. P. S., IX, 284], I expressed the belief that a careful investigation would "show a mutual connection through which all the secondary [disturbing] causes may be referred to a

single force." In my various subsequent papers, and especially in the one to which the Magellanic Premium was awarded, [Op. citat., and Trans. A. P. S., Vol. XIII, N. S. Art. VI,] I pointed out various reasons for supposing that the primal unitary force is the same that controls the motions of the several stellar systems,—in other words, the force of gravitation,—or perhaps of simple undulation,—which is manifested as heat in one of its subordinate forms, and as attraction in another. The numerical relations which I demonstrated between the disturbances of weight and of total magnetic force, were certainly noteworthy, and to my own mind, extremely satisfactory; and as further investigations have afforded additional confirmation of my views, I desire to put upon record a brief notice of the general harmony which mutually characterizes the gravitation currents and the variations of magnetic declination.

Preliminary investigations showed, as might have been reasonably anticipated, that the best quantitative results can be obtained from the observations at stations near the equator, and I therefore based my reasoning, in great measure, upon the St Helena records, and Maj. Gen. Sabine's discussions, confirming it by such incidental references to other observations, as seemed available for the purpose. At the same time allusion was made [Trans. A. P. S., loc. citat., p. 132], to researches now in progress, which may probably enable us to discover numerical relations, that will be equally satisfactory, from an examination of the observations in higher latitudes. While patiently and confidently awaiting the completion of those researches, it may be well to present some considerations which will serve both as a corroboration of my own views, and as a guide to the investigations of others.

The discussions of the magnetic and meteorological observations at Girard College [Coast Survey Reports, and Smithsonian Contributions], should be specially interesting to all Americans, and they are also among the most recent and valuable publications on terrestrial physics. From them I quote the following references to the most important and best established normal disturbances of declination.

I. "The annual variation depends on the earth's position in its orbit; the diurnal variation being subject to an inequality depending on the sun's declination. The diurnal range is greater when the sun has north declination, and smaller when south declination; the phenomenon passing from one state to the other about the time of the equinoxes." [Part II, p. 10. See, also, Toronto Obs. 2, xvii, St. Helena Obs., 2, cxviii.]

II. "At the hour of 6 or 7, in the morning, the annual variation is a maximum, disappearing at a quarter before 10 A. M., and reaching a second (secondary) maximum value at 1 P. M. It almost disappears soon after 5 P. M., and a third still smaller maximum is reached after 9 P. M. Half an hour before midnight, the annual variation again disappears. At (and before and after) the principal maximum, between 6 and 7 in the morning, the annual variation causes the north end of the magnet to be deflected to the east in summer, and to the west in winter; at 1 P. M., the deflections are to the west in summer, and to the east in winter. The range of the diurnal motion is thus increased in summer, and diminished in winter; the magnet being deflected in summer more to the east in the morning hours, and more to the west in the afternoon hours, or having greater elongations than it would have if the sun moved in the equator. In winter, the converse is the case." [Ibid. p. 12. Compare St. Hel. Obs., 2, cxviii; Toronto Obs. 1, xiv, and 2, xvi.]

III. "According to the same authority" [Gen. Sabine], "the *annual* variation is the *same* in both hemispheres, the north end of the magnet being deflected to the east in the forenoon, the sun having north declination; when in the *diurnal* variation, the north end of the magnet at that time of the day is deflected to the east in the northern hemisphere, and to the west in the southern hemisphere. In other words, in regard to direction, the law of the annual variation is the same, and that of the diurnal variation the opposite, in passing from the northern to the southern magnetic hemisphere." [Ibid. p. 13. Comp. St. Hel. Obs., 2, lxxx, cxviii.]

IV. "The regular progression of the monthly values is a feature of the annual variation deserving particular notice. There is no sudden transition from the positive to the negative side, or *vice versâ*, at or near the time of the equinoxes (certainly not at the vernal equinox); on the contrary, the annual variation seems to be regular in its progressive changes. The method here pursued is entirely different from that employed by Gen. Sabine for the same end, but the results are, nevertheless, in close accordance." It has been found that the transition takes place "*ten* days after either equinox, and also that the turning-points occur ten days after the solstices." [Ibid. p. 14. Comp. St. Hel. Obs., 2, cxx.]

V. "The general character of the diurnal motion . . . is nearly the same throughout the year; the most eastern deflection is reached a quarter before 8 o'clock in the morning (about a quarter of an hour earlier in summer, and half an hour later in winter);

. . . the north end of the magnet then begins to move westward, and reaches its western elongation about a quarter after 1 o'clock in the afternoon (a few minutes earlier in summer). . . . The diurnal curve presents but a single wave, slightly interrupted by a deviation occurring during the hours near midnight (from about 10 P. M. to 1 A. M.), when the magnet has a direct or westerly motion; shortly after 1 A. M., the magnet again assumes a retrograde motion, and completes the cycle by arriving at its eastern elongation shortly before 8 o'clock in the morning. This nocturnal deflection is well-marked in winter, vanishes in the summer months, and is hardly perceptible in the annual curve. According to the investigations of Gen. Sabine, it is probable that, if we had the means of entirely obliterating the effect of disturbances, this small oscillation would almost disappear. In summer, when it has no existence, the magnet remains nearly stationary between the hours of 8 P. M. and 3 A. M., a feature which is also shown by the annual type-curve." [Ibid. p. 20. Comp. Hobarton Obs., 2, vi; St. Hel. Obs., 2, cxi, cxix, cxx; Toronto Obs., 1, xiv, 2, xvi.]

VI. "The critical hours which vary least during the year, are those of the western elongation, and those of the morning mean declination. The extreme difference between the value for any month and the mean annual value, is 31 minutes in the former, and 28 minutes in the latter." [Ibid. p. 21.]

VII. The curves of lunar-diurnal variation "show two east and two west deflections in a lunar day," the westerly maxima "occurring about the upper and lower culminations," and the easterly maxima "at the intermediate six hours. The total range hardly reaches 0'.5. These results agree generally with those obtained for Toronto and Prague." [Part III, p. 8. Comp. St. Hel. Obs., 2, xxiii, lxxxii, cxliv; Toronto Obs., 3, lxxxv.]

VIII. In comparing the easterly and westerly curves, "the constant in Bessel's formula comes out zero, and hence it is inferred that the moon has no specific action in deflecting the magnet by a constant quantity." [Ibid. p. 10.]

IX. "If we take the four phases into account, the lunar action seems to be retarded ten minutes, which quantity may be termed the *lunar-magnetic* interval for the Philadelphia station. At Toronto, the intervals are not so regular." [Ibid. p. 11.]

X. "The characteristic feature of the annual inequality in the lunar-diurnal variation, is a much smaller amplitude in winter than in summer. Kreil, indeed, inferred from the ten-year series of the

Prague observations, that in winter the lunar-diurnal variation either disappears, or is entirely concealed by irregular fluctuations, requiring a long series for their diminution. The method of reduction which he employed was, however, less perfect than that now used. The second characteristic of the inequality consists in the earlier occurrence of the maxima and minima in winter than in summer. The winter curve precedes the summer curve by about one and three quarter hours." [Ibid. p. 12—13.]

XI. The curves of semi-annual variation, at all points where continuous observations have been made, present a striking similarity, the amount of deflection being nearly equal in all parts of the globe. [See diagram, Pt. II, p. 12. Comp. St. Helena Obs., 2, cxix; Toronto Obs. 2, xvi, xvii.]

Now it is evident that the mechanically-polarizing currents (Proc. A. P. S., IX, 367 sqq), must be variously deflected at different periods of the day, in consequence of the gravitation disturbances arising both from the varying distance of the sun, and from solar heat. Although it may sometimes be desirable to consider the so-called thermal currents apart from those which would be produced independently of any change of temperature, such a distinction is unnecessary in a preliminary qualitative investigation like the present, because the periods both of maxima and of minima are precisely coincident in the two currents (except as they may be slightly modified by the earth's radiant heat), and because *even the thermal currents are occasioned simply and solely by the varying gravitation* of fluids of varying density.

Regarding, therefore, the air and æther over any given magnetic meridian, during the day hours the intertropical, and during the night the extra-tropical, portions will be most drawn towards the sun, and the following deflections will be thus produced in the portions nearest the equator :

	6 to 12 A. M.	12 to 6 P. M.	6 to 12 P. M.	12 to 6 A. M.
Northern zones,	S. E.	S. W.	S. E.	S. W.
Southern " "	N. E.	N. W.	N. E.	N. W.

The night disturbances, whether from variations of temperature, or from simple fall towards the sun (the distance fallen varying as the square of the time from midnight), will be very slight. The earth's rotation, centrifugal force, and atmospheric inertia, tend to throw each of the phases forward, and to increase the magnitude of the westerly, while they diminish the easterly deflections. If these

modifications were sufficient to override the slight easterly tendency at 6 to 12 P. M., and to advance the phases one hour, the disturbances would assume the following forms, the change between 7 P. M. and 1 A. M. being scarcely, if at all, perceptible:

	7 A. M. to 1 P. M.	1 P. M. to 7 A. M.
Northern zones, . . .	S. E.	S. W.
Southern " . . .	N. E.	N. W.

At the equinoxes, the amounts of deflection in the northern and southern magnetic hemispheres should be equal; at other seasons, the shortest lines would suffer the greatest displacement, the deflections being greatest in the northern zones from April to September, when the sun is in the northern signs, and in the southern zones from October to March, when the sun is in the southern signs. My experiments have shown that the compass-needle sympathizes with, and is, to some extent, controlled by purely mechanical vibrations; and if, in obedience to such control, it should tend to parallelism with the æthereal currents, a westerly disturbance of declination (the declination being always conventionally referred to the north pole of the needle), would correspond either to an equatorial southeasterly deflection of the southern, or a northwesterly deflection of the northern extremity of a half-meridian; and an easterly disturbance to a southwesterly deflection of the southern, or a northeasterly deflection of the northern extremity.

Substituting these declination values for the current deviations to which they correspond, the almost *precise* accordance of theory and observation in the prominent features of the normal variations of declination may be seen by a reference to the following table:

Daily maximum.*	}	Easterly.	Westerly.	Morning Mean.	Evening Mean.	Stationary.
Half yearly " Apl. to Sept. †		Easterly.	Westerly.			
" " " Oct. to Mar. ‡		Westerly.	Easterly.			
Theoretical,		7 A. M.	1 P. M.	10 A. M.	4 P. M.	7 P. M. to 1 A. M.
Observed [I to V] ‡		6-8 A. M.	1 P. M.	9½ A. M.	5 P. M.	8 P. M. to 3 A. M.

Gen. Sabine, in speaking of the opposition of the annual and semi-annual curves (St. Hel. Obs., 2, exix), says "these remarkable systematic dissimilarities, may be regarded as sufficient indications of a difference in the *mode of operation* of the solar influence in the two cases." I am not aware that any attempt has hitherto been made to explain this apparent difference, or to show that it is only

* In the northern zones.

† Over the whole earth.

‡ The bracketed references are to the numbered quotations from the Girard College discussions.

apparent, and may result from the action of a uniform law. I believe that I have now given the needed explanation, and since I have shown experimentally that the phenomena are such as *should* be produced by gravitation, it is reasonable to assume that they probably *are* so produced. The probability is increased by the disappearance of the night oscillation in summer (V), the probability that when it is observed, it results from thermal disturbances, and the greater stability of those critical hours which are nearest to the hours of maximum sunward gravitation (VI).

The precise coincidence, both in time and direction, of the lunar-diurnal declination and tidal curves (VII), the unavoidable inference that the moon has no constant or specific magnetic action (VIII), the "establishment" of ten minutes at the Philadelphia station (IX), the correspondence of the lunar and solar curves in the diminished winter amplitude (X), and the uniformity at all stations of the semi-annual variation curves (XI), are all necessary corollaries of my hypotheses.

The demonstration of a connection between the daily and annual variations of magnetism and gravitation would be incomplete, if our theory could not be so extended as to explain the decennial and secular changes. For such an extension we are compelled to wait until further study and observation have more precisely defined the character and value of those changes, and suggested all the important gravitation disturbances of long period to which they may be plausibly referred. We may find, however, in the attraction of Jupiter, one of the possible causes of the 10-11 year period, while nutation, precession,* geological upheaval and depression, change of seasons, accumulation or diminution of polar ice, and the shifting position of the centre of gravity of our planetary system, must all necessarily contribute to the production of gradual changes in the terrestrial gravitation currents. The belief does not, therefore, seem unreasonable, that the feeble vibrations of the tremulous needle may not only furnish us with a delicate scale for weighing (as we have already approximately done), the huge mass of the sun, but they may also aid us in the discovery and verification of other important cosmical phenomena, and the assignment of their appropriate laws.

Although it is probable that terrestrial magnetism is mainly owing to currents circulating above the surface, it is well known that there

* Hansteen supposed that the motion of the magnetic poles was connected with the precession of the equinoxes.

are also earth-currents, which exert an appreciable modifying influence. I am confident that they will be found equally obedient to the laws of gravitation, which affect every particle of the earth's body, modifying the crystalline polarity and cohesion of solids as well as the flow of liquids, and producing internal tides, which may contribute largely to that metamorphism of stratified rocks which has been referred by geologists to the agency of heated fluids and vapors. (See Rogers, Pa. Report, 2,700; Lyell, Amer. Jour. of Science, [2], 39,22.)

The inclination presents some anomalies that are difficult to explain, and whether we compare the solar-diurnal or the annual curves at the principal northern and southern stations, the "indications of a difference in the *mode of operation* of the solar influence in the two cases" seem as striking and perplexing, as they did to Hudson and Herschel in their examination of the influence of heat on the barometer (Proc. A. P. S. IX, 283), and to Sabine, in his discussion of the semi-annual declination curves (St. Hel. Obs., 2, exix). But the disappearance, in the progress of our investigations, of these once seemingly insurmountable difficulties,—the wonderful coincidence in the general features of the gravitation and magnetic currents,—and the *a priori* probability that all disturbed forces, of whatever character or variety, will tend constantly to a mutual equilibrium,—encourage the belief that this apparent paradox may be likewise susceptible of a simple interpretation which will drive it from its latest lurking-place.

I can think, at this moment, of no more probable causes of the want of symmetry here spoken of, than the different distribution of land and water in the two hemispheres, and the influence of powerful alternating land and sea breezes.* A long series of connected observations at a number of new stations may, perhaps, be required, before it can be satisfactorily ascertained whether the disturbances thus occasioned are sufficient to account for all the phenomena, but meanwhile it is interesting to observe the degree of accordance that exists at northern inland stations, like Philadelphia and Toronto, between the curves of vertical force and force of wind on the one hand, and those of horizontal force and barometric pressure on the other, as well as the agreement that has been pointed out by Dr. Lloyd and Mr. Homer, between the annual curves of declination and of temperature.

* The dependence of declination upon land lines and ocean currents, is shown by isogonic charts.

The ballot-boxes were then examined by the presiding officer, and the following gentlemen were declared duly elected members of the Society, viz.:

- Mr. S. Austin Allibone, of Philadelphia.
- Mr. Samuel F. Haven, of Worcester, Massachusetts.
- Mr. Charles D. Cleveland, of Philadelphia.
- Mr. James B. Francis, of Lowell, Massachusetts.
- Mr. George C. Shafer, of Washington, D. C.
- Mr. Timothy B. Conrad, of Philadelphia.

And the Society was then adjourned.

Stated Meeting, May 5, 1865.

Present ten members.

President, Dr. WOOD, in the chair.

Letters accepting membership were received from S. Austin Allibone, dated 1816 Spruce Street, April 25; from Charles D. Cleveland, dated 248 South Eighth Street, April 26; from J. B. Francis, dated Lowell, May 1, and from S. F. Haven, dated Worcester, Mass., May 2, 1865.

Letters of invoice were received from the Society at Göttingen, February 13, and the Minister of the Interior at La Haye, March 13, 1865.

Donations for the Library were received from M. Miani, the Royal Society at Göttingen, the Geological Institute at Vienna, the King and the Natural History Society of Holland, the London Astronomical, Meteorological, Geographical and Chemical Societies, the Leeds Geological and Philosophical Societies, the Royal Societies at Edinburgh and Dublin, the Dublin Geological Society, and Quarterly Journal of Science; the Canada Survey, the Essex Institute, Rhode Island Society, Young Men's Association at Buffalo, Philadelphia Academy of Natural Sciences, Blanchard & Lea, Sherman & Co., Pliny E. Chase, and the National Academy of Sciences at Washington.